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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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In the Matter of	)	
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Amendment of Part 97 of the	)	RM-8737
Commission's Rules Governing	)	
the Amateur Radio Service to	)	
Facilitate Spread Spectrum	)	
Communications	)	

To: The Commission

The following are the comments of Robert A. Buaas, K6KGS, 20271 Bancroft Circle, Huntington Beach, CA 92646.

I hold the Special Temporary Authorization dated December 27, 1994, that permits experimentation with any Spread Spectrum (SS) technology in all Amateur spectrum above 50 Megahertz, on behalf of the entire Amateur community. My involvement with Amateur SS dates back to its original contemplation by AMRAD, in whose STA I participated. I have contributed to the development of successful commercial Part-15 SS systems, and I am a charter member in IEEE P802.11 (the Wireless LAN Ethernet Standard development project).

I wholly support the thesis of Sections I and II of the ARRL's proposal, that the Amateur Rules should be significantly relaxed for SS. As I said in my March 1993 report to the Chief, Private Radio Bureau giving results of our investigations, a part of which is quoted in the proposal, one barrier limiting the application of SS in Amateur Radio are the limitations in the Rules.

Since that report, I have come to appreciate that there are additional barriers. One is the complexity of even the simplest SS system, compared with the equivalent-performance narrowband analog, particularly in a community of participants where cost of equipment is very sensitive. As I said previously, SS is not currently for the light-at-heart. Virtually none of the currently available amateur equipment can be utilized in the SS mode without major modifications and enhancements. The technical challenges of properly creating a quality SS signal for transmission (the easy part), then synchronizing the receiver (generally the hard part) are beyond most practitioners. There is considerable confusion about what constitutes SS; some writers describe SS only in terms of Direct Sequence modulation, other only Frequency Hopping. I prefer to think in the broadest possible terms, referring back to the original definition of the transformation of narrowband information transmitted over a wide spectrum regardless of the spreading means. So often, what

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gets lost are the benefits that result from the additional complexity: (a) the increased reliability of the communication channel resulting from the improved resistance to jamming and effects of multipath fading, and (b) the ability to accommodate heavier spectrum loading before performance degradation sets in.

A third and overwhelming barrier is the fear associated with the interference that the inexperienced claim that all SS systems will necessarily generate. On this point we have experienced vocal opposition to SS, particularly from the Frequency Coordination community, and to a lesser degree from the Weak Signal community. The fear is often expressed as: "SS will raise the noise floor." While this is true in the abstract (just as any energy emitter makes some contribution to that which each receiver must differentiate), few real systems operate anywhere near the noise floor. Those amateurs that do would profit from applying SS technology, as Phil Karn often observes. (Virtually every commercial and military weak signal application is deeply invested in signal coding technology; SS is but one segment on this information processing continuum.) NBFM routinely operates with signal margins of 20 to 40 dB; because of this, the noise floor contribution of multiple SS systems is insignificant.

There is an important point here that must not be overlooked. For SS to be successful in Amateur Radio, high priority must be given at the system design stage to a criteria which minimizes interference to narrowband occupants. Attempting to draw interference impact conclusions by analyzing the performance of commercial and military SS designs is seriously flawed, particularly when one uses system models designed against very different criteria. For example, systems whose design criteria are (a) meet Part-15.247 requirements and (b) maximize channel data rate, do not optimize for minimum interference. As another example, one of AMRAD's first experiments used commercially available NBFM transceivers to evaluate frequency hopping. The extremely slow slewing performance of the frequency synthesizer required that each transmission dwell for a long period before moving on to the next channel in the hopping sequence. At the time this experiment was conducted, many repeater systems used only carrier squelch as an access method, and the long dwell resulted in unwanted repeater transmitter keyups. The annoyance this caused the user community was reflected in the Rules change originally permitting SS. Today, commercial product synthesizer slew performance is only slightly better. Yet most repeaters have additional criteria which must be met before transmitter activation occurs. These increased system requirements were brought on by the desire for selective repeater access and by the need for the repeater to avoid unintentional interference from intermodulation products of nearby emitters. Our tests have conclusively shown that, in today's environment, that original system would represent only a slight but noticeable impact. Using advanced synthesizer design, we have demonstrated that continuous SS transmissions go completely unnoticed in all but a few special cases of users. (One example is a very high density packet data channel, where an occasional packet is lost and is recovered by later retransmission.) Except for the frequency synthesizer, the transmitter is an ordinary NBFM transmitter; it has the usual spectral power distribution and spurious emission characteristics, and is consistent in every way with good engineering practice. This evaluation system was realized as a point-to-point link and did not confront the issue of wideband receiver overload. As expected, we observed superior resistance to the kind of interference that most plagues fixed-frequency systems.

The above example is but one possible SS realization. There is considerable room for additional gain. Phil Karn's work in Forward Error Correction has yet to be exploited. Use of one-half rate codes only doubles the transmitted signal bandwidth, giving it a direct-sequence-like spectral distribution and gain. Such novel ideas show that the current rules prohibiting complex hybrid systems were shortsighted. SS is but one form of "coding." In order that The Commission provide the longest-reaching regulatory environment that encourages responsible innovation and advancement in the state of the art, instead of changing the Rules as proposed in paragraphs 9 and 10 of the subject NPRM, I recommend that The Commission remove Section 97.311 entirely, and include SS as part of authorized "unspecified digital codes" in Section 97.309(b).

Making provision for international use of SS and other novel signaling technology as suggested by the spirit of paragraph 8 is a worthwhile modification. IEEE 802.11 is truly an international endeavor, and there is worldwide interest in commercial SS in this form. I have received queries about our progress from several radio amateurs in Europe, the Middle East, and Japan, who were first exposed to SS as a result of the IEEE project. Future developments will certainly commingle between the commercial product domain and Amateur Radio.

The proposal made in paragraph 11 to require automatic power control ONLY for SS systems is one minor aspect of an elegant incentive first offered by Phil Karn. It only makes sense if implemented completely as Phil proposed it, and then only if it is applied to ALL systems competing for spectrum use. The notion of using minimum transmitter power required to accomplish the desired communication is well established in the current Rules (Section 97.313(a)), yet it is one of the most abused and violated requirements. I know of very few repeater systems who have any power control at all and none in which the output power is automatically controlled based on some criteria relating to communication quality. 97.313(a) observance is marginally better among HF amateur operators. Unless SIGNIFICANT incentive is provided to offset the considerable system complexity increase (the hardware needed to control power output is simple, the algorithms required to determine how to dynamically adjust the hardware are not), I believe that the guidance provided in the existing Rules is adequate.

I take serious exception to the general direction and the specific proposal made in paragraph 7 of this NPRM. SS is a complex art. Precious few amateurs have been willing to contribute their time and resources to participate in the development of amateur SS. Even the incentive offered by the STA has been insufficient to bring out interest in large numbers. Nowhere in the current Rules is any emission relegated to "test only" status. Parties wishing to test may apply for a Part-5 license. What incentive is offered to the developer to build a new SS system if all he/she can do is test it? Amateurs build new systems so that they may field them, to gain on-the-air experience in both the new system's strengths and weaknesses. This experience is invaluable to the communication art, because the criteria applied in judging the system is different from that used for systems in other radio services. Further testing of SS is not required. Our investigations have conclusively demonstrated the viability of SS along side existing users and modes, that proper use of good engineering practice and appropriate design criteria practically eliminate postulated interference. Our work now is to produce and field enough SS systems that more amateurs can participate in their use and experience for themselves the merits. The result achieved by implementing this Rules change as proposed REDUCES the chance that SS will ever find application in Amateur Radio. Such a direction is directly counter to the basic purpose for the existence of our Service.

This NPRM is silent on another important aspect of the STA, particularly the authorization for the use of 50 Megahertz and above. The VHF bands have propagation properties which differ dramatically from UHF and up. It is precisely these characteristics that deserve investigation using SS and other coding technology. 2 Meters is the most heavily congested of the VHF bands; it also provides the best vehicle for proving the promise that CDMA has to offer in increasing spectrum utilization. Commercial systems have made the case of documenting this improvement when the spectrum is clear of other use (the design criteria and implementation reflect this thrust). Amateur radio has the potential for making an invaluable contribution: that there are gains available even when the spectrum used is occupied. It is my recommendation that The Commission adopt a change in the Rules permitting SS the VHF band operation that is given me and my associates in the STA.

SS is the 1990's version of SSB, when it was introduced as an improvement to AM. The outcry I heard then rings familiar today, as the fearful contemplate this "new" mode. SS emission has been authorized in the Amateur Service for more than a decade. No interference to 75 cm operations has been documented at any time during this period. Further, transmissions conducted under the auspices of the STA have produced no noticeable interference. I have offered the availability of the STA's capability to any and all Amateurs wishing to do serious research consistent with the objectives stated in the STA. Some SS enthusiasm has been expressed by Weak Signal interests and this is an exciting occurrence. SSB had a powerful influence in revolutionizing the communications art. I encourage and recommend that The Commission turn aside this proposal in favor of the direction and authorizations provided in the STA, further encouraging widespread SS introduction, utilization and evaluation.

Respectfully submitted,

Robert A. Buaas